

**GLOBAL PRECIPITATION MEASUREMENT
PRECIPITATION PROCESSING SYSTEM**

**File Specification
2AGPROFGMI**

Preliminary Version

January 22, 2014

0.1 2AGPROFGMI - Radiometer Profiling

2AGPROFGMI, "Radiometer Profiling", generates surface rainfall and vertical hydrometeor profiles on a pixel by pixel basis from radiometer brightness temperature data using the Goddard Profiling algorithm GPROF2014. Because the vertical information comes from a radiometer, it is not written out in independent vertical layers like the TRMM Precipitation Radar. Instead, the output is referenced to one of 100 typical structures for each hydrometeor or heating profile. These vertical structures are referenced to as profiles in the output structure. Vertical hydrometeor profiles can be reconstructed to 28 layers by knowing the profile number (i.e. shape) of the profile and a scale factor that is written for each pixel.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	221	Number of pixels in each scan.
nspecies	5	Number of hydrometeor species. Species are defined in speciesDescription in the DataHeader group.
sddim	12	Number of characters in each species description.
ntemps	21	Number of profile temperature indeces. Indeces are defined in temperatureDescriptions in the DataHeader group.
nlyrs	28	Number of profiling layers. The top height of each layer is defined in hgtTopLayer in the DataHeader group.
nprf	100	Number of unique profiles for each species and 2 meter Temperature index.

Figure 1 through Figure 5 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):

FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):

InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):

NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):

FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

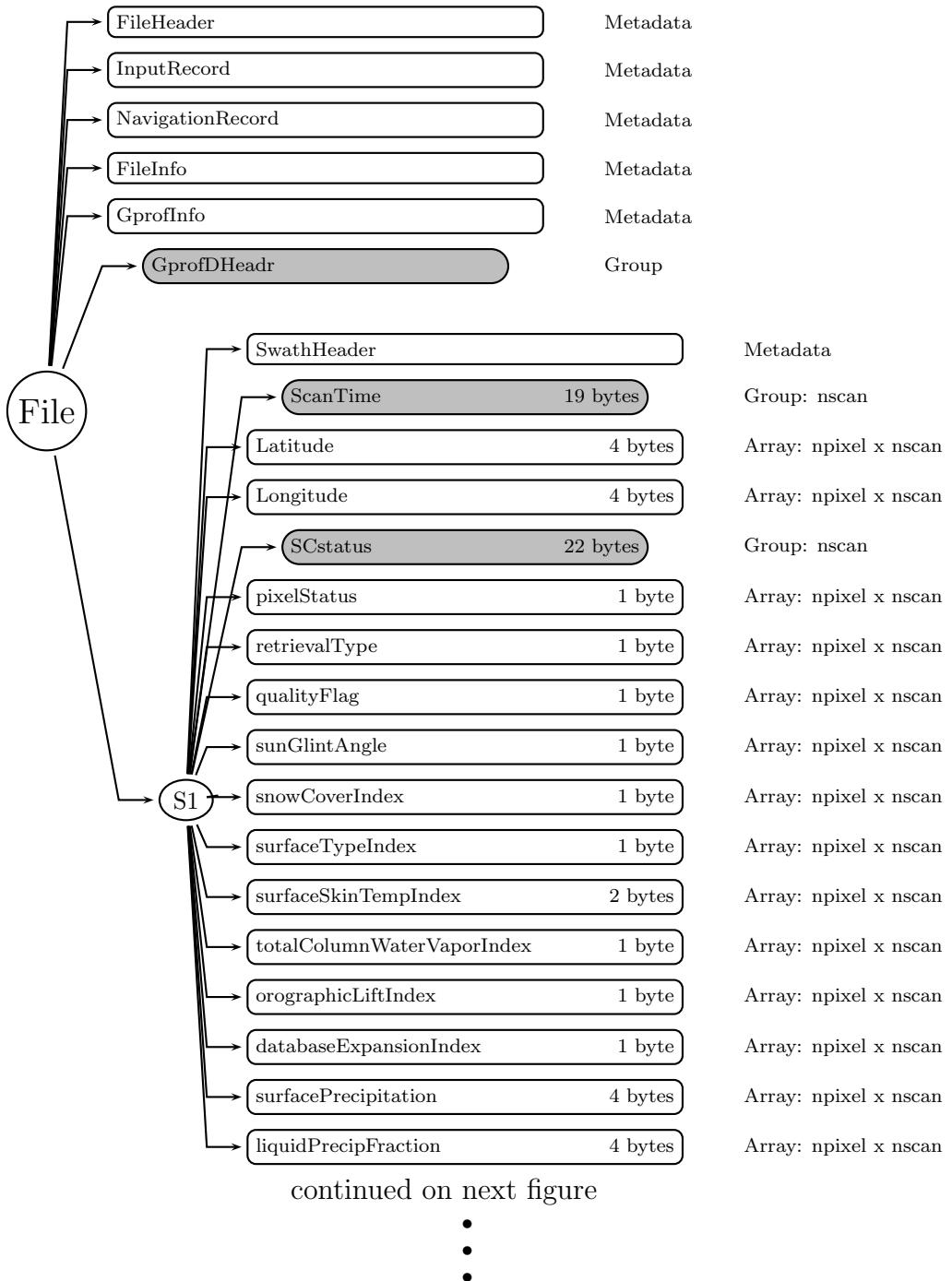


Figure 1: Data Format Structure for 2AGPROFGMI, Radiometer Profiling

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continued from last figure



Figure 2: Data Format Structure for 2AGPROFGMI, Radiometer Profiling

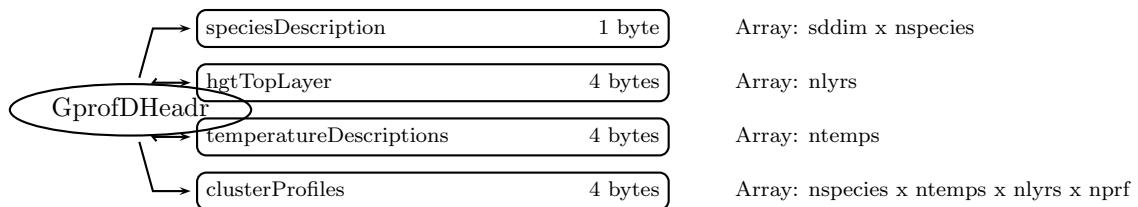


Figure 3: Data Format Structure for 2AGPROFGMI, GprofDHeadr

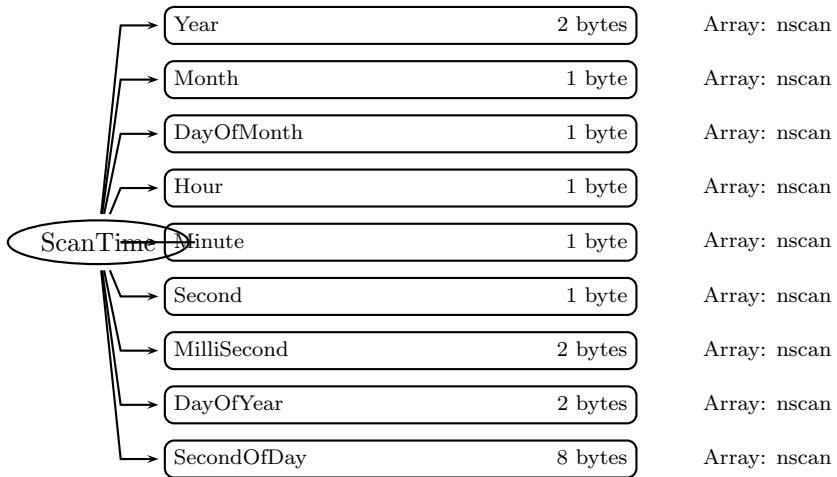


Figure 4: Data Format Structure for 2AGPROFGMI, ScanTime

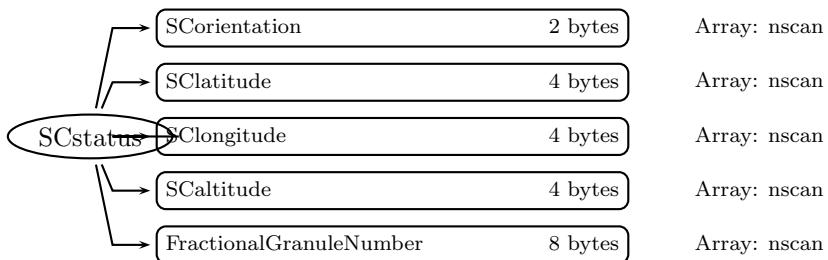


Figure 5: Data Format Structure for 2AGPROFGMI, SCstatus

GprofInfo (Metadata):

GprofInfo contains metadata required by Gprof. Used by 2A12 only. See Metadata for GPM Products for details.

GprofDHeadr (Group)**speciesDescription** (1-byte char, array size: sddim x nspecies):

Description of each species. Special values are defined as:

255 Missing value

hgtTopLayer (4-byte float, array size: nlyrs):

Height of the top of each of 28 atmospheric layers in the clusterProfiles. The tops are every 0.5 km up to 10 km, then every km after that up to 18.0 km. Values are: 0.5, 1.0, ... 9.5, 10.0, 11.0, ... 18.0. Values range from 0 to 18.0 km. Special values are defined as:
-9999.9 Missing value

temperatureDescriptions (4-byte float, array size: ntemps):

Temperature of 2 meter temperature indeces of clusterProfiles. Values are in C. Special values are defined as:

-9999.9 Missing value

clusterProfiles (4-byte float, array size: nspecies x ntemps x nlyrs x nprf):

Standard GPM profile structures. Dimensions are hydrometeor/heating species (4); 2 meter temperature index (21); vertical layers (28); and profile number (100). To recover values in a profile see the description below in the variable profileScale.

Special values are defined as:

-9999.9 Missing value

S1 (Swath)**SwathHeader** (Metadata):

SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group)**Year** (2-byte integer, array size: nscan):

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan):

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan):

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan):

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan):

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

Millisecond (2-byte integer, array size: nscan):

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):

A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Latitude (4-byte float, array size: npixel x nscan):

The earth latitude of the center of the IFOV at the altitude of the earth ellipsoid. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):

The earth longitude of the center of the IFOV at the altitude of the earth ellipsoid. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCstatus (Group)

SCorientation (2-byte integer, array size: nscan):

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan):

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan):

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SClatitude (4-byte float, array size: nscan):

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan):

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule.

Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

pixelStatus (1-byte integer, array size: npixel x nscan):

If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
0 : Valid pixel
1 : Boundary error in landmask
2 : Boundary error in sea-ice check
3 : Boundary error in sea surface temperature
4 : Invalid time
5 : Invalid latitude/longitude
6 : Invalid brightness temperature
7 : Invalid sea surface temperature
-99 : Missing value
```

retrievalType (1-byte integer, array size: npixel x nscan):

Specifies that for this pixel, the rain retrieval was made with the S0, S1, or S2 (values are 0,1,2).

qualityFlag (1-byte integer, array size: npixel x nscan):

qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 99).

High: Good retrieval using the GPM derived profile databases

Medium: Retrieval using the GPM derived profile databases.
over coastal areas or in areas of oceanic sunglint.

Low: Retrievals using at-launch databases.

Valid values include:

0 : High quality (retrieval is good, use it)

1 : Medium quality (use with caution)

2 : Low quality (recommended qualitative use only)

-99 : Missing value

sunGlintAngle (1-byte integer, array size: npixel x nscan):

Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. sunGlintAngle is the angular separation between the reflected satellite view vector and the sun vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. If this angle is less than ten degrees, the pixel is affected by sunglint and qualityFlag for the pixel is lowered. Values range from 0 to 180 degrees. Special values are defined as:

-99 Missing value

snowCoverIndex (1-byte integer, array size: npixel x nscan):

An index based on snow depth. Not currently implemented. Values range from 0 to 5. Special values are defined as:

-99 Missing value

surfaceTypeIndex (1-byte integer, array size: npixel x nscan):

Indicates the type of surface (Range 0 - 99).

Codes include

```
1 : Ocean
2 : Sea-Ice
(3-12 are 'land classification')
3 : Maximum Vegetation
4 : High Vegetation
5 : Moderate Vegetation
6 : Low Vegetation
7 : Minimal Vegetation
8 : Maximum Snow
9 : Moderate Snow
10 : Low Snow
11 : Minimal Snow
12 : Standing Water and Rivers
13 : Water/Land Coast Boundary
14 : Water/Ice Boundary
15 : Land/Ice Boundary
-99 : Missing value
```

surfaceSkinTempIndex (2-byte integer, array size: npixel x nscan):

Surface temperature from the model, used to select the correct database profiles.

totalColumnWaterVaporIndex (1-byte integer, array size: npixel x nscan):

Liquid equivalent of the total water vapor column used to select the correct database profiles. Values range from 0 to 75 mm. Special values are defined as:

-99 Missing value

orographicLiftIndex (1-byte integer, array size: npixel x nscan):

Index of potential orographic enhancement to precipitation based on vertical motion, atmospheric moisture profile, wind direction, and terrain slope. Not currently implemented.

Special values are defined as:

-99 Missing value

databaseExpansionIndex (1-byte integer, array size: npixel x nscan):

Expansion factor of the profile search radius in the profile database beyond the search nominal range. If there are fewer than the minimum number of profiles in the selected database boundaries, then the search radius is expanded. Values range from 0 to 255.

surfacePrecipitation (4-byte float, array size: npixel x nscan):

The instantaneous precipitation rate at the surface for each pixel. Check pixelStatus for a valid retrieval. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

liquidPrecipFraction (4-byte float, array size: npixel x nscan):

Fraction of surface precipitation that is liquid. Values range from 0 to 1. Special values are defined as:

-9999.9 Missing value

convectPrecipFraction (4-byte float, array size: npixel x nscan):

Fraction of surface precipitation that is convective. Values range from 0 to 1. Special values are defined as:

-9999.9 Missing value

probabilityOfPrecip (4-byte float, array size: npixel x nscan):

A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Database profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:

-9999.9 Missing value

mostLikelyPrecipitation (4-byte float, array size: npixel x nscan):

The surface precipitation value with the highest occurrence within the Bayesian retrieval. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

precip1stTertial (4-byte float, array size: npixel x nscan):

The surface precipitation value at the 1st tertiary of the precipitation distribution. Values are in mm/hr. Special values are defined as:

-9999.9 Missing value

precip2ndTertial (4-byte float, array size: npixel x nscan):

The surface precipitation value at the 2nd tertiary of the precipitation distribution. Special values are defined as:

-9999.9 Missing value

numOfSignificantProf (2-byte integer, array size: npixel x nscan):

Number of profiles used in the Bayesian average above 2 sigma. Profiles below this threshold are still used in the average, but are not included in this 'significant' profiles

parameter. Special values are defined as:

-9999 Missing value

rainWaterPath (4-byte float, array size: npixel x nscan):

Total integrated rain water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2 . Special values are defined as:

-9999.9 Missing value

cloudWaterPath (4-byte float, array size: npixel x nscan):

Total integrated cloud liquid water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2 . Special values are defined as:

-9999.9 Missing value

mixedWaterPath (4-byte float, array size: npixel x nscan):

Total integrated mixed phase water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2 . Special values are defined as:

-9999.9 Missing value

iceWaterPath (4-byte float, array size: npixel x nscan):

Total integrated cloud ice water in the vertical atmospheric column. Values range from 0 to 3000 kg/m^2 . Special values are defined as:

-9999.9 Missing value

totalColumnWaterVapor (4-byte float, array size: npixel x nscan):

Total integrated water vapor in the vertical atmospheric column, also known as total precipitable water (TPW). Values range from 0 to 3000 kg/m^2 . Special values are defined as:

-9999.9 Missing value

spare (2-byte integer, array size: npixel x nscan):

Spare variable. Special values are defined as:

-9999 Missing value

spareIndex (1-byte integer, array size: npixel x nscan):

Spare index variable. Special values are defined as:

-99 Missing value

temp2mIndex (2-byte integer, array size: npixel x nscan):

Temperature 2 meter height Index in the clusterProfiles array. See profileScale description below. Values range from 1 to 21. Special values are defined as:

-9999 Missing value

profileNumber (2-byte integer, array size: nspecies x npixel x nscan):

Profile Number in the clusterProfiles array for each species. See profileScale description below. Values range from 1 to 100. Special values are defined as:

-9999 Missing value

profileScale (4-byte float, array size: nspecies x npixel x nscan):

profileScale is used to scale the values of the clusterProfiles array.

In order to recover a value of a single pixel,
select your species, layer, and temp2mIndex,
then use profileNumber and profileScale
to obtain the value:

Where:

S = species (1-5)
Species defined in speciesDescription
T = temp2mIndex (1-21)
Temperatures defined in temperatureDescriptions
L = profile layer (1-28) Top of each layer
specified in hgtTopLayer
P = profileNumber (1-100) for species S

In a Fortran program,

```
P = profileNumber(S)
Pixel Value = profileScale(S) * clusterProfiles(S,T,L,P)
```

In a C program,

```
P = profileNumber[S-1]
Pixel Value = profileScale[S] * clusterProfiles[P-1][L-1][T-1][S-1]
```

C Structure Header file:

```
#ifndef _TK_2AGPROFGMI_H_
#define _TK_2AGPROFGMI_H_

#ifndef _SCSTATUS_
#define _SCSTATUS_

typedef struct {
    short SCorientation;
    float SClatitude;
    float SClongitude;
    float SCaltitude;
    double FractionalGranuleNumber;
} SCSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_
```

```

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L2AGPROFGMI_S1_
#define _L2AGPROFGMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    SCSTATUS SCstatus;
    signed char pixelStatus[221];
    signed char retrievalType[221];
    signed char qualityFlag[221];
    signed char sunGlintAngle[221];
    signed char snowCoverIndex[221];
    signed char surfaceTypeIndex[221];
    short surfaceSkinTempIndex[221];
    signed char totalColumnWaterVaporIndex[221];
    signed char orographicLiftIndex[221];
    signed char databaseExpansionIndex[221];
    float surfacePrecipitation[221];
    float liquidPrecipFraction[221];
    float convectPrecipFraction[221];
    float probabilityOfPrecip[221];
    float mostLikelyPrecipitation[221];
    float precip1stTertial[221];
    float precip2ndTertial[221];
    short numOfSignificantProf[221];
    float rainWaterPath[221];
    float cloudWaterPath[221];
    float mixedWaterPath[221];
}

```

```

    float iceWaterPath[221];
    float totalColumnWaterVapor[221];
    short spare[221];
    signed char spareIndex[221];
    short temp2mIndex[221];
    short profileNumber[221][5];
    float profileScale[221][5];
} L2AGPROFGMI_S1;

#endif

#ifndef _GPROFDHEADER_
#define _GPROFDHEADER_

typedef struct {
    unsigned char speciesDescription[5][12];
    float hgtTopLayer[28];
    float temperatureDescriptions[21];
    float clusterProfiles[100][28][21][5];
} GPROFDHEADER;
#endif
#endif

```

Fortran Structure Header file:

```

STRUCTURE /SCSTATUS/
    INTEGER*2 SCorientation
    REAL*4 SCLatitude
    REAL*4 SClongitude
    REAL*4 SCaltitude
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond

```

```

INTEGER*2 DayOfYear
REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AGPROFGMI_S1/
  RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
  RECORD /SCSTATUS/ SCstatus
    BYTE pixelStatus(221)
    BYTE retrievalType(221)
    BYTE qualityFlag(221)
    BYTE sunGlintAngle(221)
    BYTE snowCoverIndex(221)
    BYTE surfaceTypeIndex(221)
    INTEGER*2 surfaceSkinTempIndex(221)
    BYTE totalColumnWaterVaporIndex(221)
    BYTE orographicLiftIndex(221)
    BYTE databaseExpansionIndex(221)
    REAL*4 surfacePrecipitation(221)
    REAL*4 liquidPrecipFraction(221)
    REAL*4 convectPrecipFraction(221)
    REAL*4 probabilityOfPrecip(221)
    REAL*4 mostLikelyPrecipitation(221)
    REAL*4 precip1stTertial(221)
    REAL*4 precip2ndTertial(221)
    INTEGER*2 numOfSignificantProf(221)
    REAL*4 rainWaterPath(221)
    REAL*4 cloudWaterPath(221)
    REAL*4 mixedWaterPath(221)
    REAL*4 iceWaterPath(221)
    REAL*4 totalColumnWaterVapor(221)
    INTEGER*2 spare(221)
    BYTE spareIndex(221)
    INTEGER*2 temp2mIndex(221)
    INTEGER*2 profileNumber(5,221)
    REAL*4 profileScale(5,221)
END STRUCTURE

STRUCTURE /GPROFDHEADR/
  CHARACTER speciesDescription(12,5)
  REAL*4 hgtTopLayer(28)
  REAL*4 temperatureDescriptions(21)

```

```
REAL*4 clusterProfiles(5,21,28,100)
END STRUCTURE
```